Post-processing forecasts from a convective-permitting weather model for national flow forecasting

C. Cattoën[1a], T. Carey-Smith[1b], Q.J. Wang[2], J. C. Bennett[3], D. E. Robertson[3]

[1]NIWA, [a]Christchurch, [b]Wellington, New Zealand

[2]U. of Melbourne, Melbourne, Australia

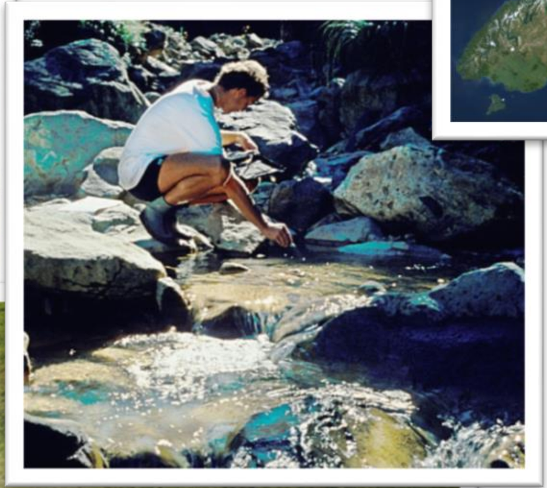
[3]CSIRO, Melbourne, Australia

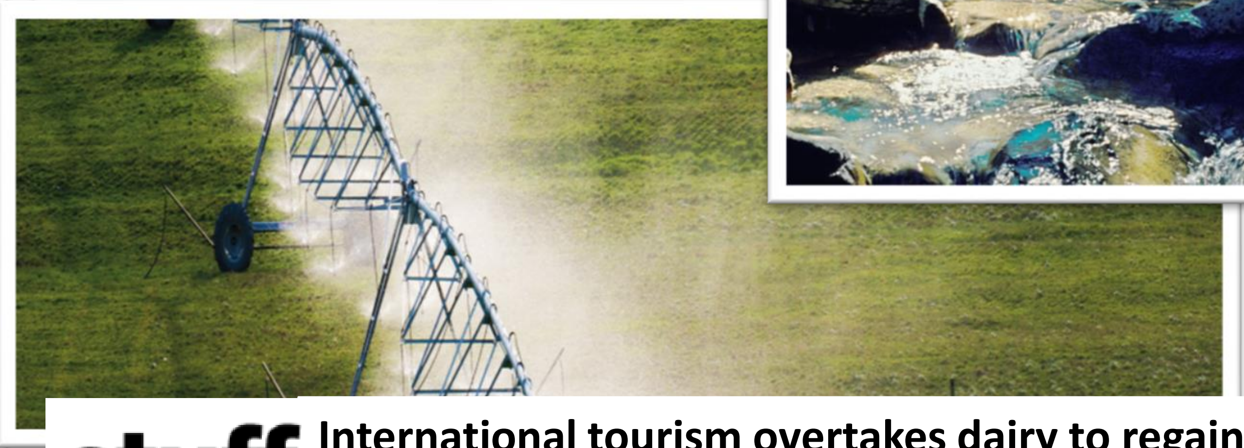
HEPEX 2018, Melbourne, Australia, 6th-8th February 2018

enhancing the benefits of New Zealand's natural resources

NIWA Taihoro Nukurangi

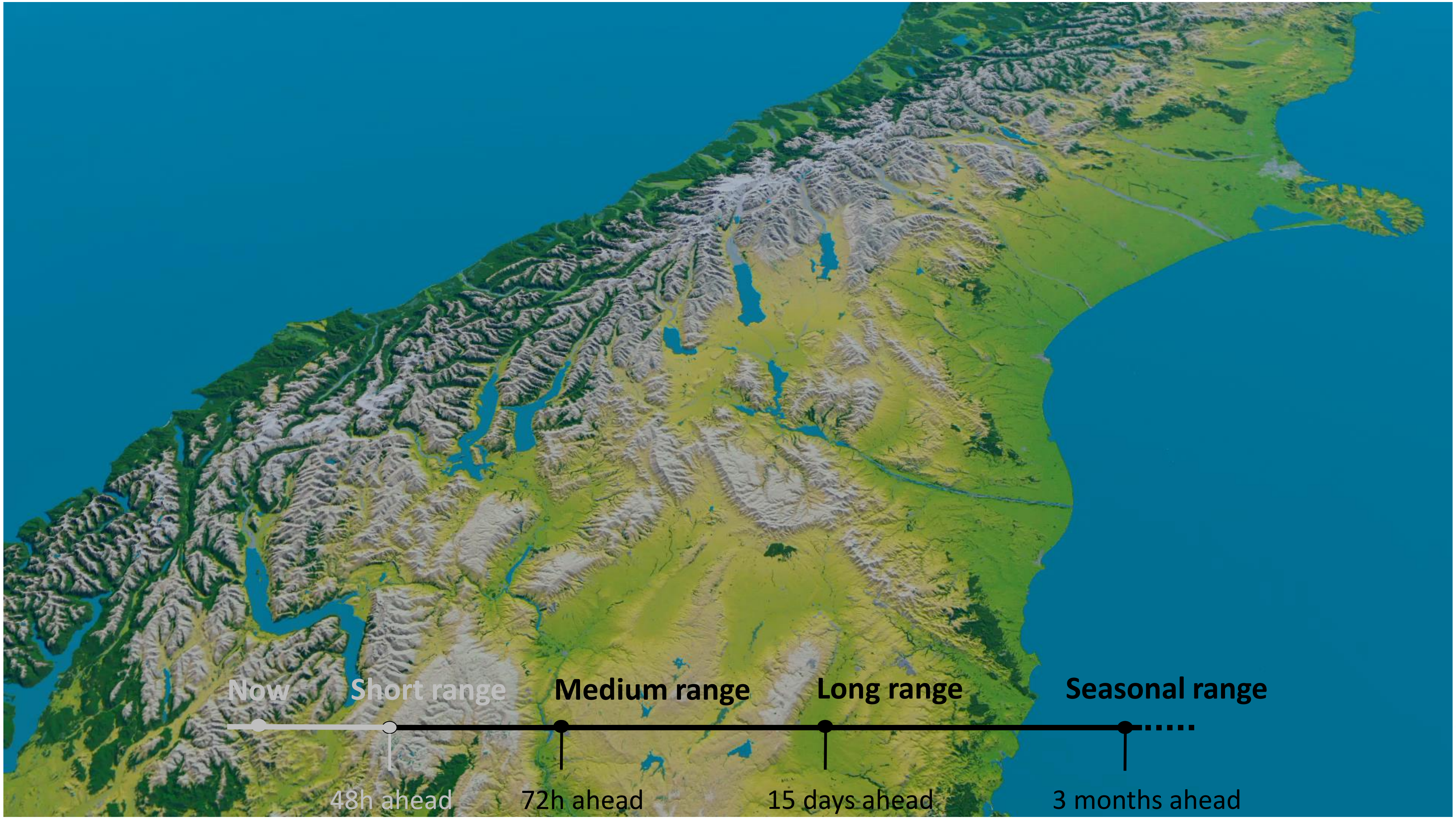
Water in New Zealand





stuff International tourism overtakes dairy to regain top spot as our biggest export earner

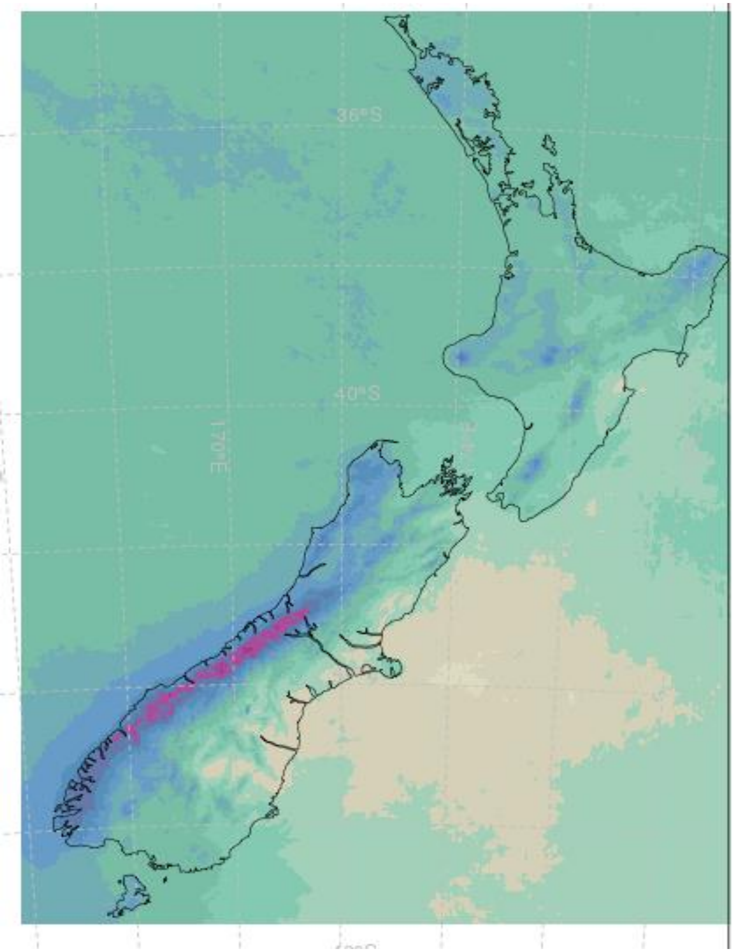
Towards a national flow forecasting system



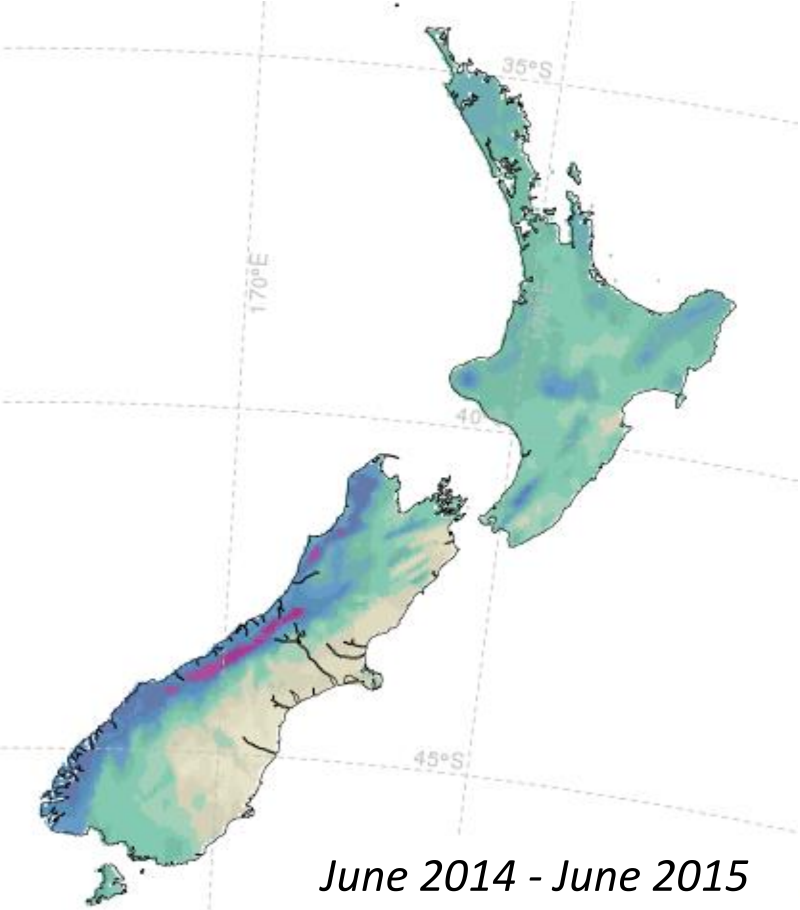
Weather model: general performance

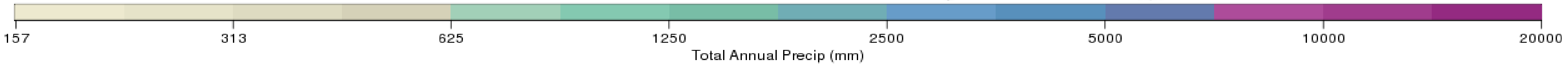
Cloud-resolving model gives a much more realistic annual mean rainfall distribution

Forecast 1.5km- Convective scale



“Observed” product 5km

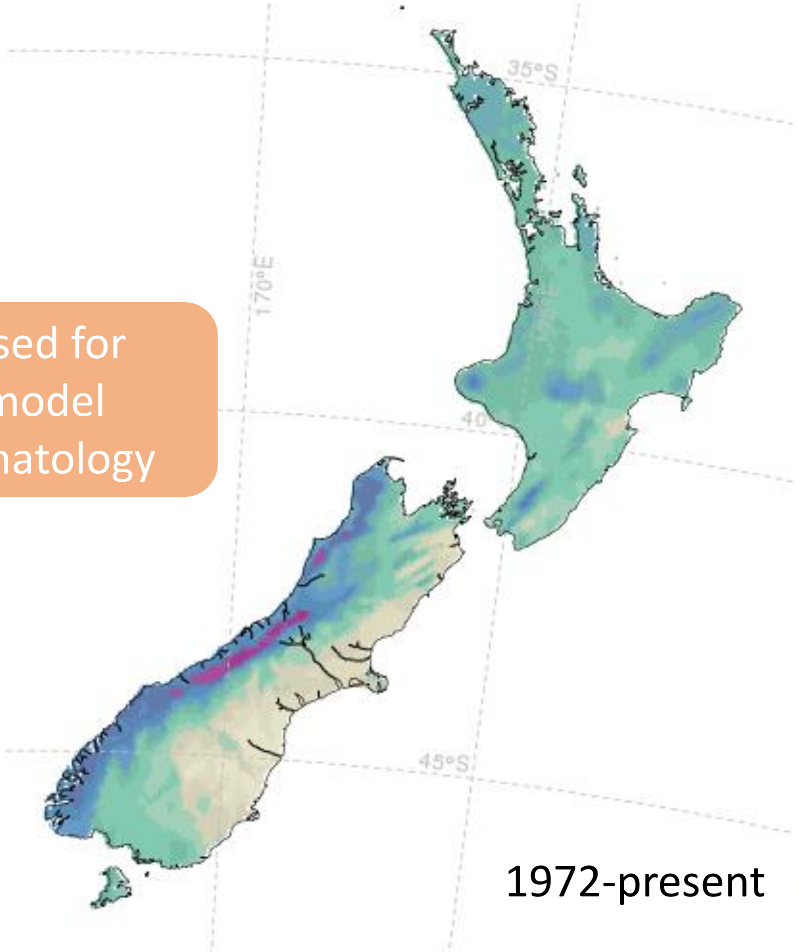




Observed data at NIWA

“Observed” product 5km, daily (VCSN)

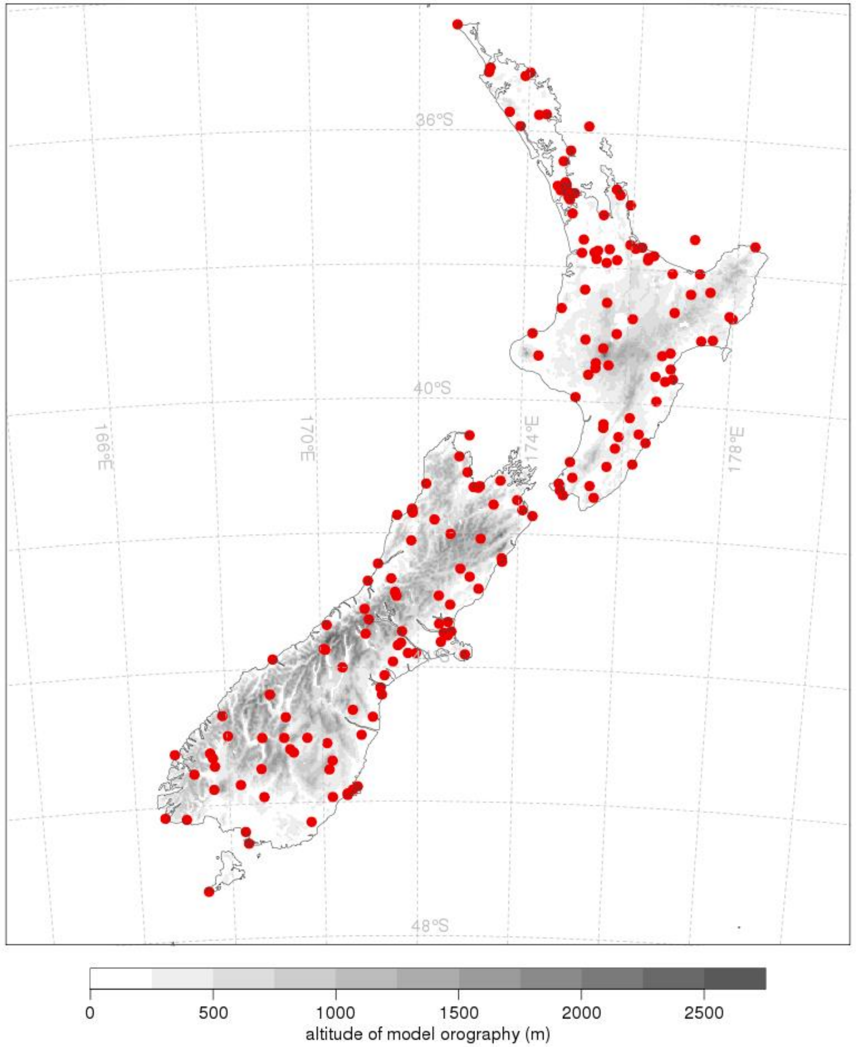
Used for model climatology



1972-present

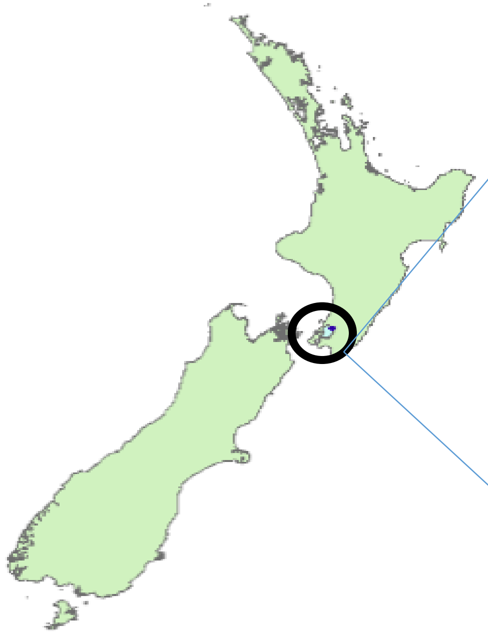
[1] Woods, R.A.; Hendrikx, J.; Henderson, R.D.; Tait, A.B. 2006: Estimating mean flow of New Zealand rivers. Journal of Hydrology (NZ), 45(2): 95-110.

Station data at NIWA

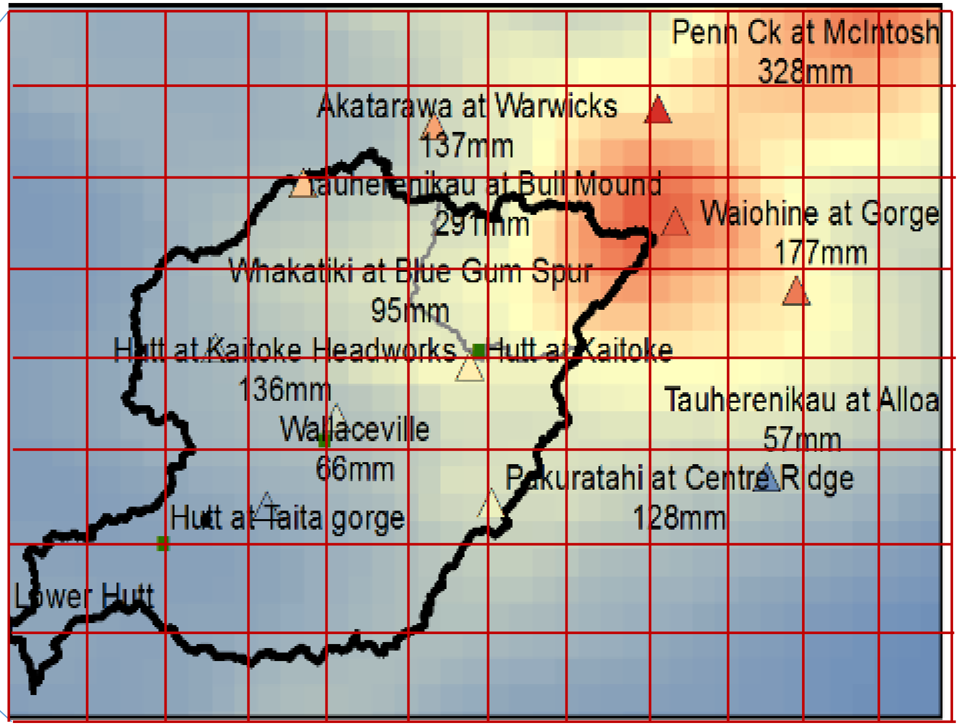


Aim – National forecast precipitation calibration

Hutt catchment



Weather Forecast 1.5km, hourly



Gridded observed data 5km, daily

Daily data

Hourly forecasts

Case study:

- 3 year forecast archive
- 12 stations (hourly) elevation 42m-1022m

Rainfall post-processing

Approach #1:
Baseline – Hourly data

- Baseline
- Calibration using hourly data

Approach #2:
Pseudo-hourly data

- Daily data
- Hourly disaggregation:
  - raw forecast (rain)
  - divide by 24h (no rain)
- Calibration using pseudo-hourly data

Approach #3:
Daily data

- Daily data
- Calibration using daily data
- Hourly disaggregation:
  - Historical raw forecasts

Bayesian rainfall forecast post-processor

(Robertson, Shrestha, Wang, 2013, HESS)

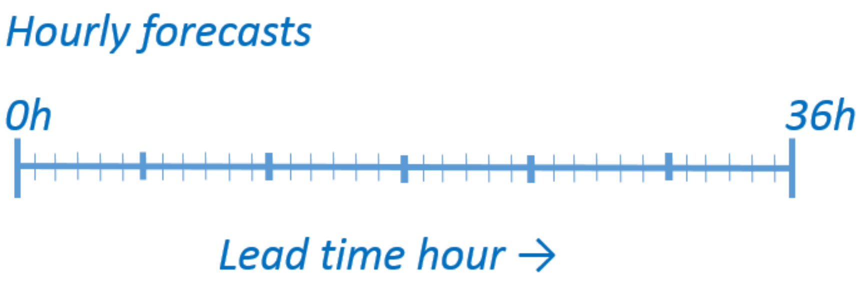
Approach #1:
Baseline- Hourly data

Approach #2:
Pseudo-hourly data

Step 1: Correct biases and quantify uncertainty

Simplified Bayesian joint probability (BJP) model (Wang et al 2009)

- Log-sinh transformation (Wang, Shrestha, Robertson, Pokhrel, 2012, WRR)
- Continuous bivariate normal distribution
- Treatment of zero data (Wang and Robertson 2011)



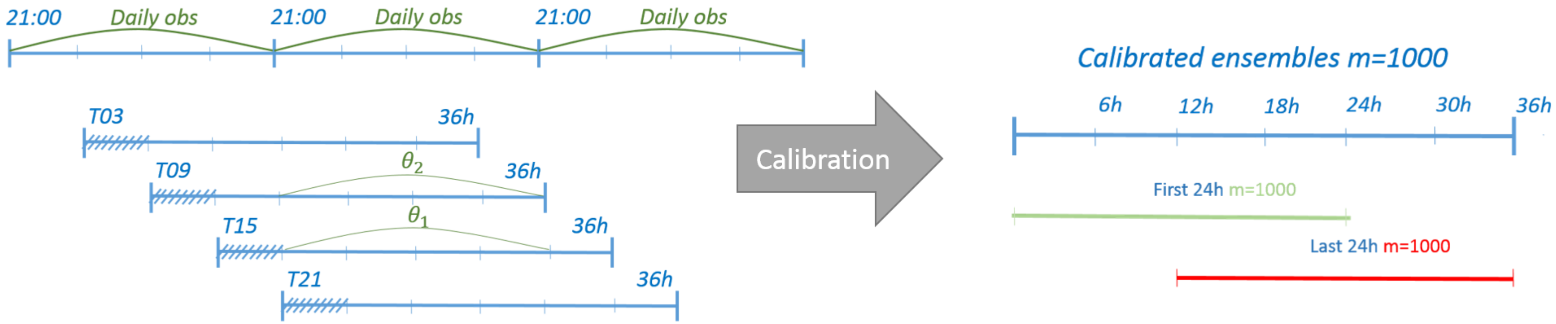
Step 2: Instill temporal and spatial patterns

Schaake Shuffle (Clark, Gangopadhyay, Hay, Rajagopalan, Wilby, 2004, JHM)

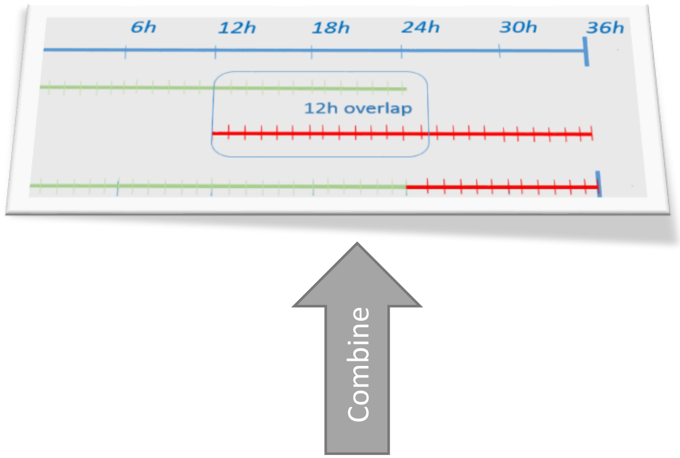
Template data: historical observed data

Bayesian rainfall forecast post-processor

Step 1: Correct biases and quantify uncertainty

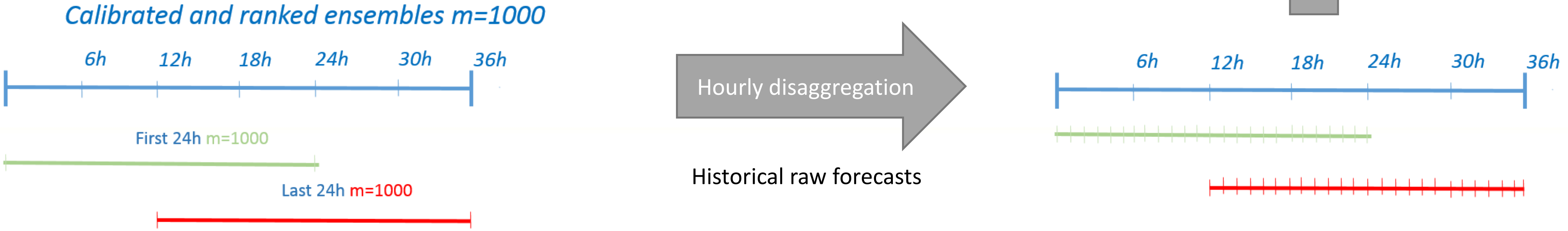


Step 3: Hourly disaggregation and combine overlapping forecasts



Step 2: Instill temporal and spatial patterns

Template data: historical ~~observed~~ raw forecast data



Results

Approach #1:
Baseline – Hourly data

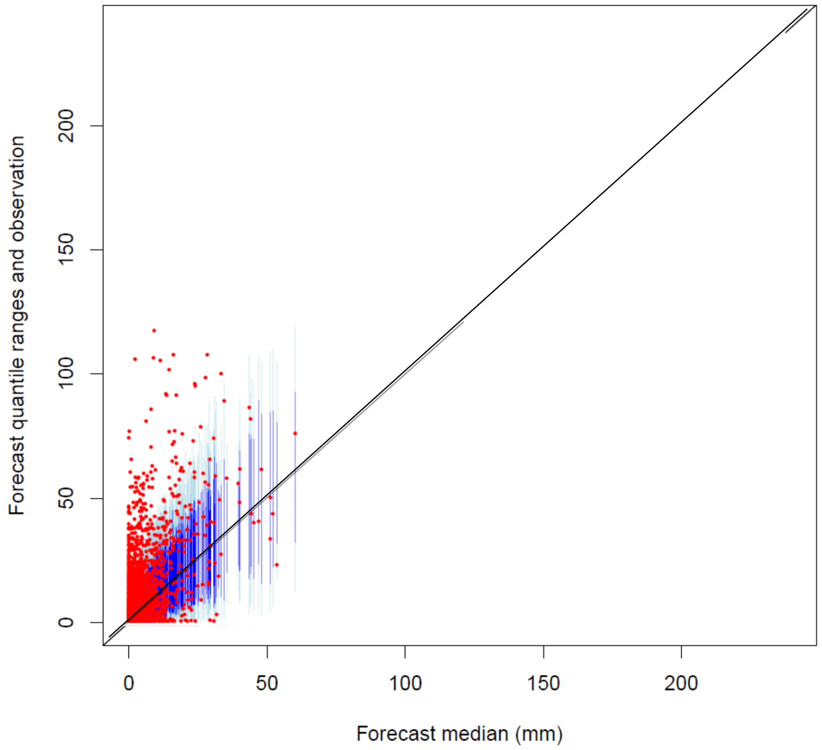
Approach #2:
Pseudo-hourly data

Approach #3:
Daily data

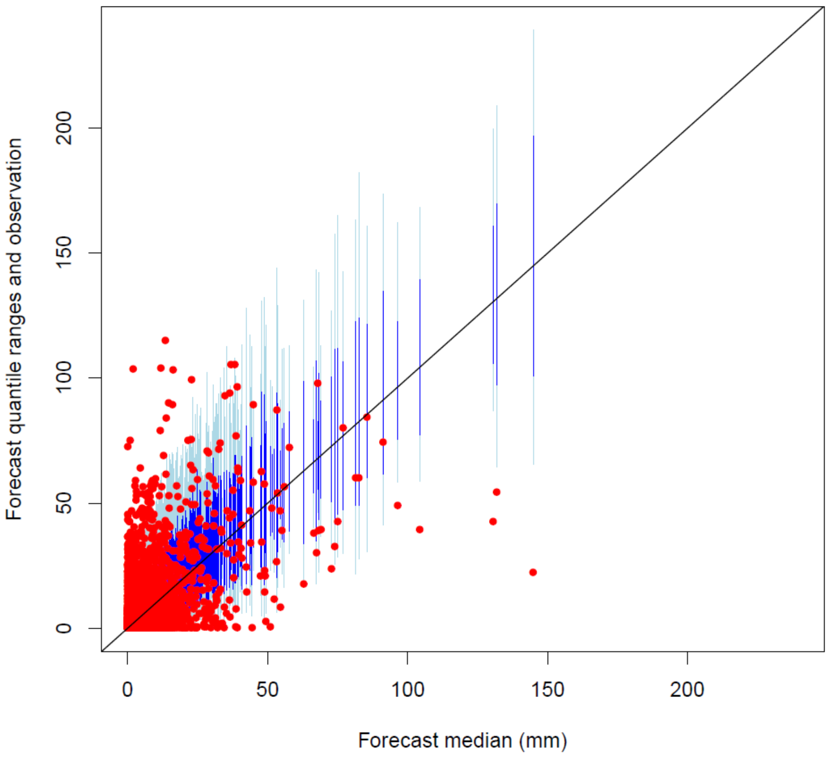
Results – Total daily precipitation (1-24h)

Ensemble ranges and observations versus ensemble mean

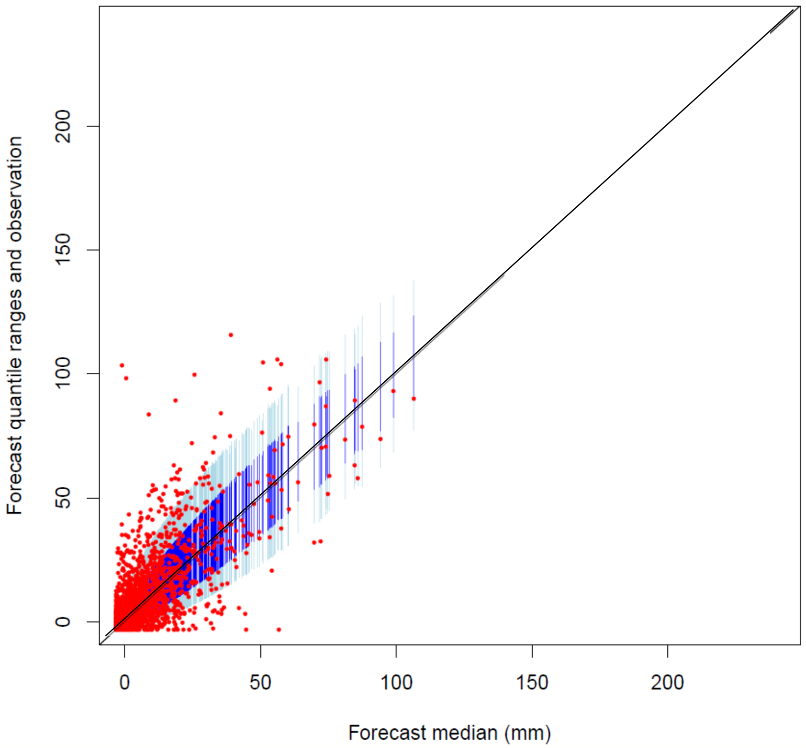
Approach #1:
Baseline – Hourly data



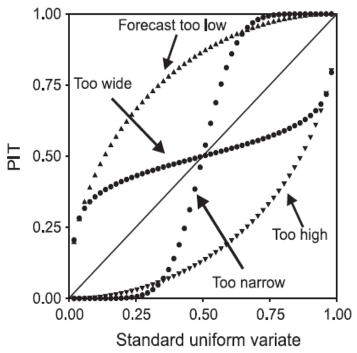
Approach #2:
Pseudo-hourly data



Approach #3:
Daily data



Results – Reliability of daily total precipitation (1-24h)

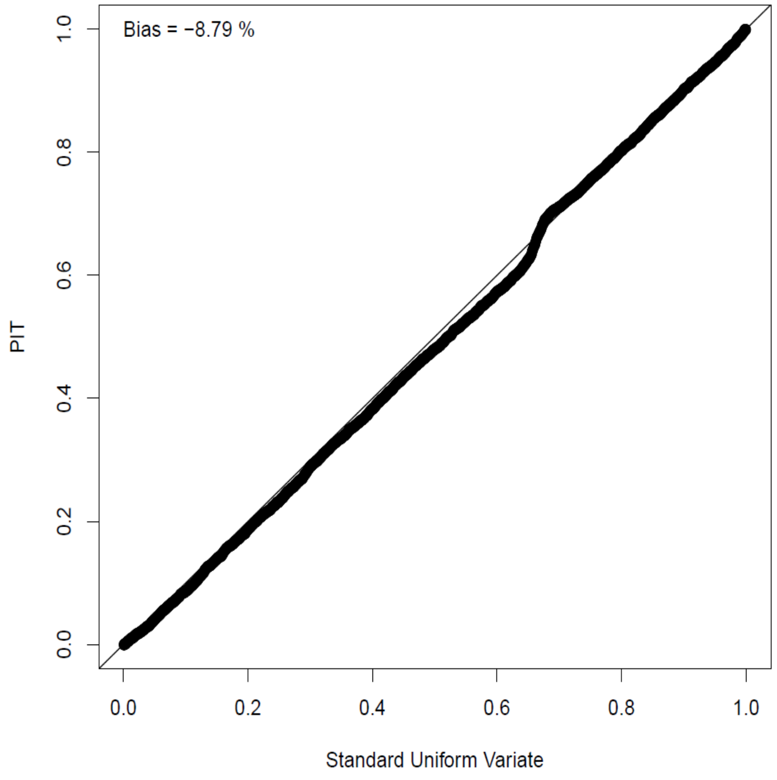


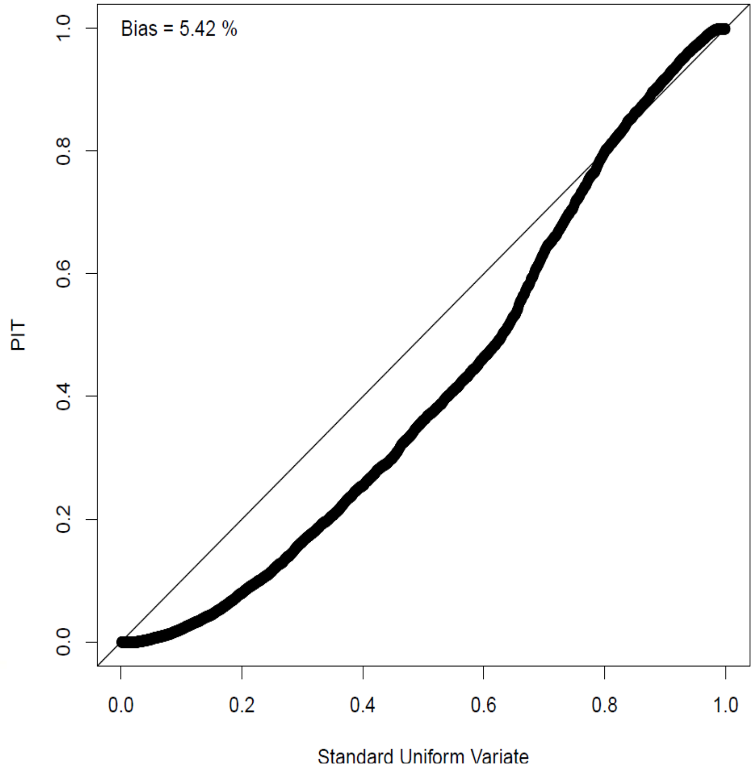
PIT: forecast reliability

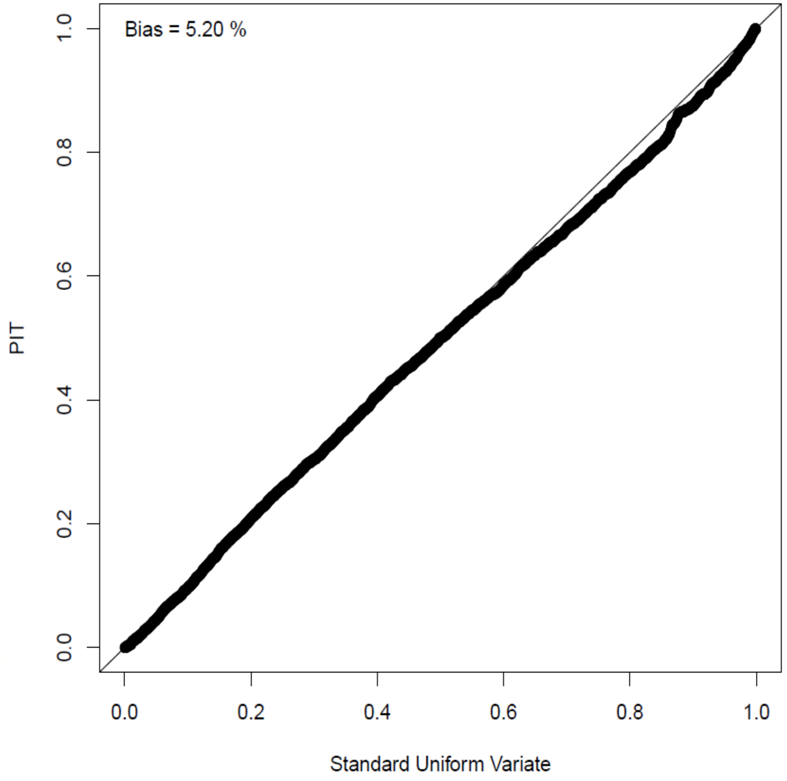
Approach #1: Baseline – Hourly data

Approach #2: Pseudo-hourly data

Approach #3: Daily data







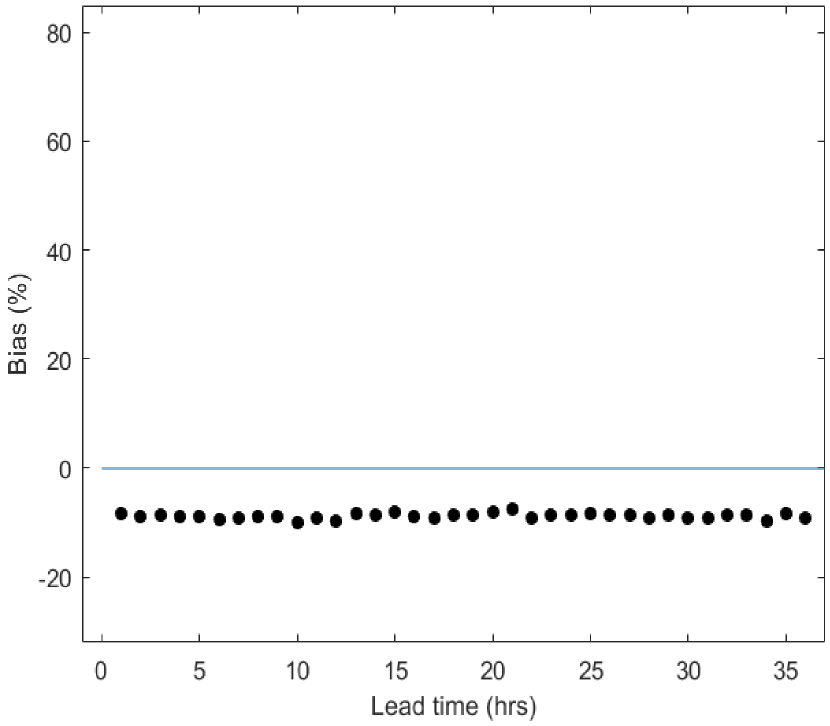
Results – Hourly disaggregation

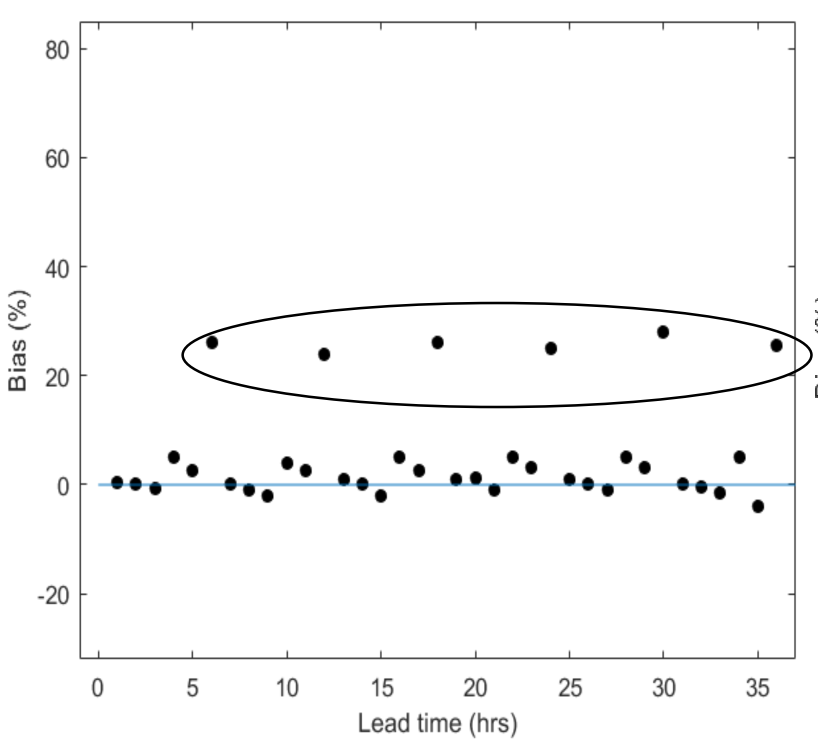
Percentage bias per lead time

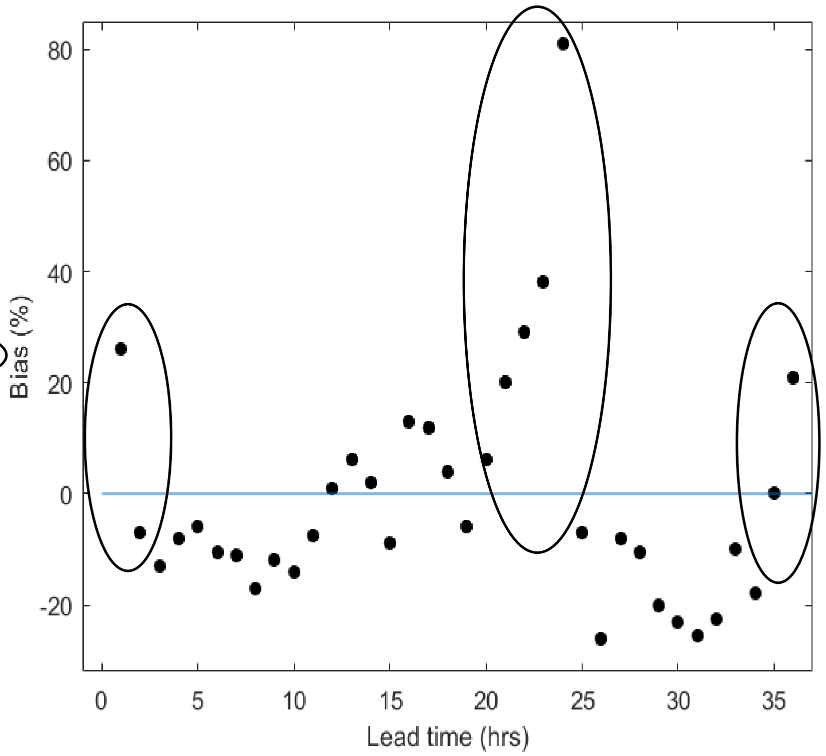
Approach #1:
Baseline – Hourly data

Approach #2:
Pseudo-hourly data

Approach #3:
Daily data



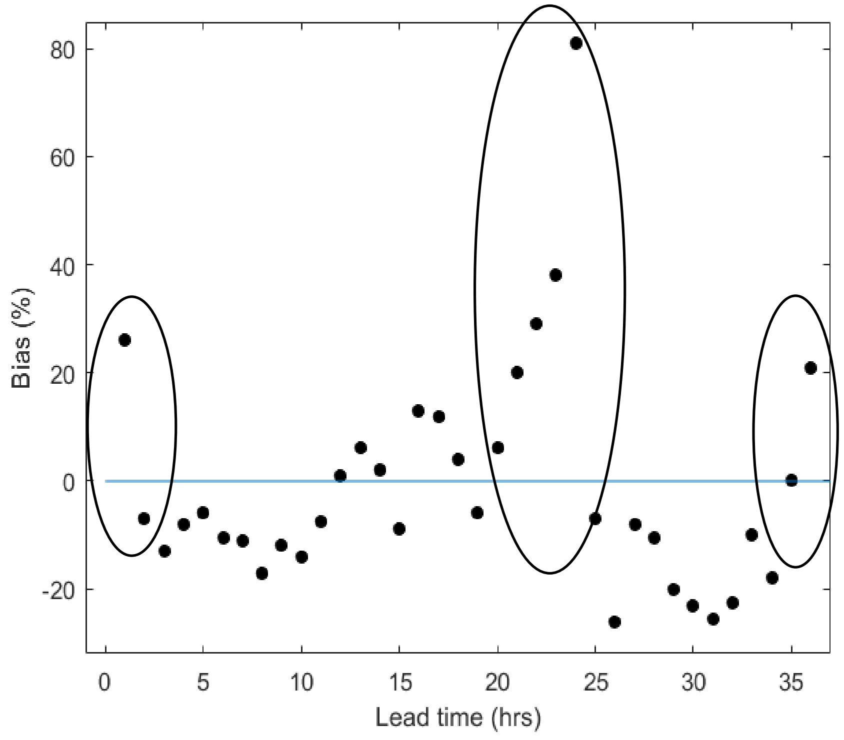




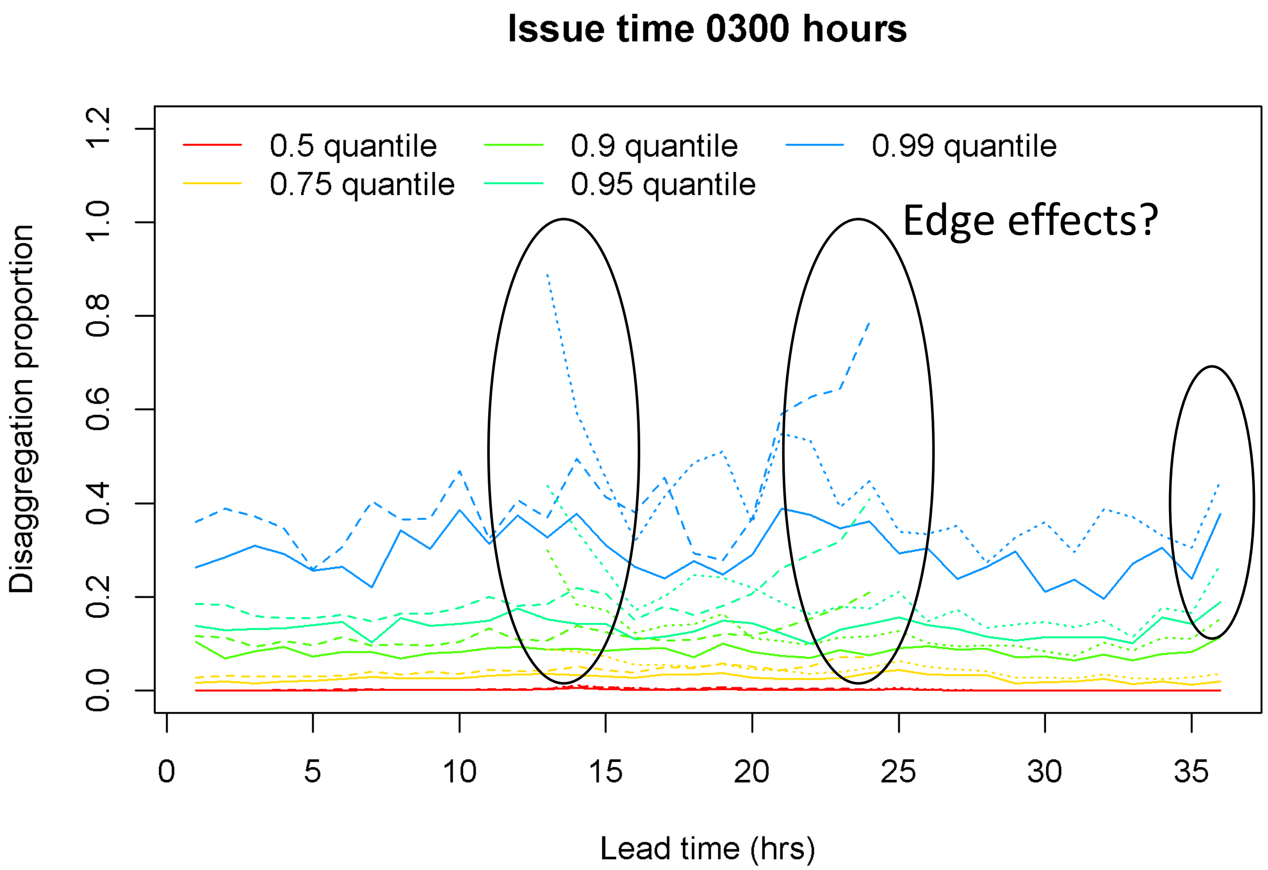
Results – Hourly disaggregation

Approach #3: Daily data

Historical raw forecasts

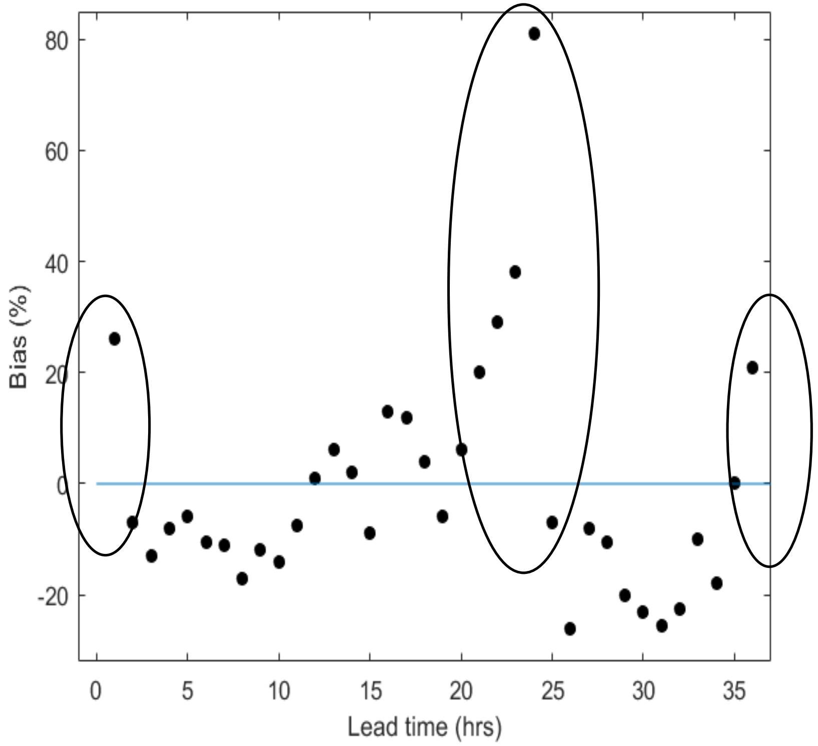


Precipitation disaggregation proportion

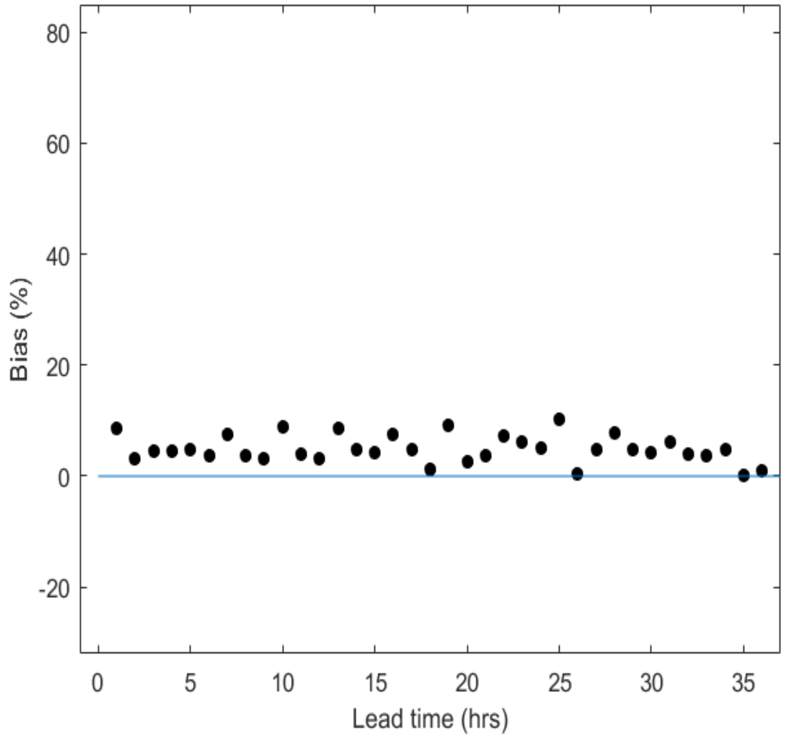


Results – Hourly disaggregation

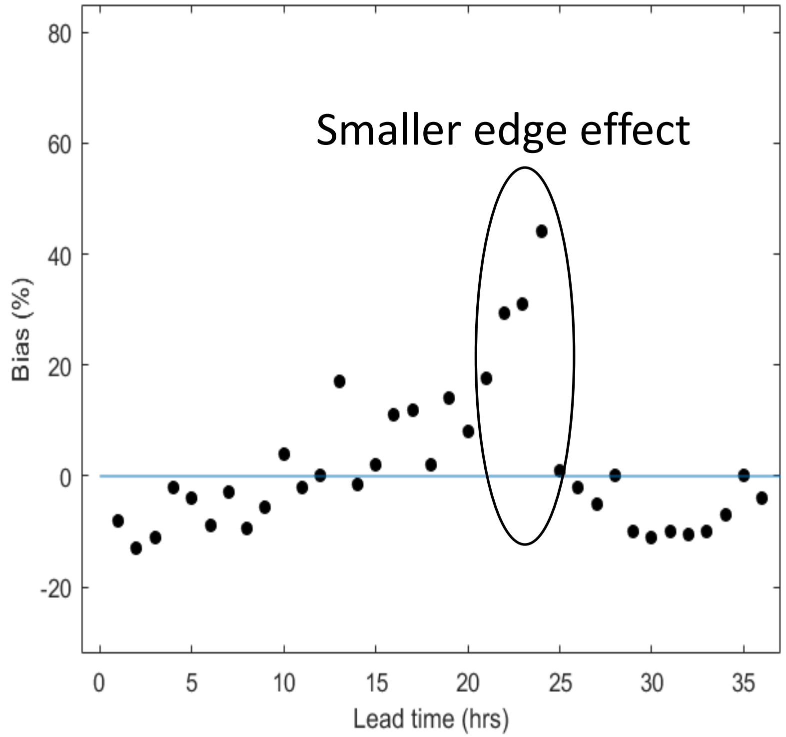
Historical raw forecasts



Stochastic



Mixed:
raw forecast (rain)/ stochastic (no rain).



Results – Summary

Approach #1:
Baseline – Hourly data

- Ideal case
- Removed bias
- Reliable ensemble

Approach #2:
Pseudo-hourly data

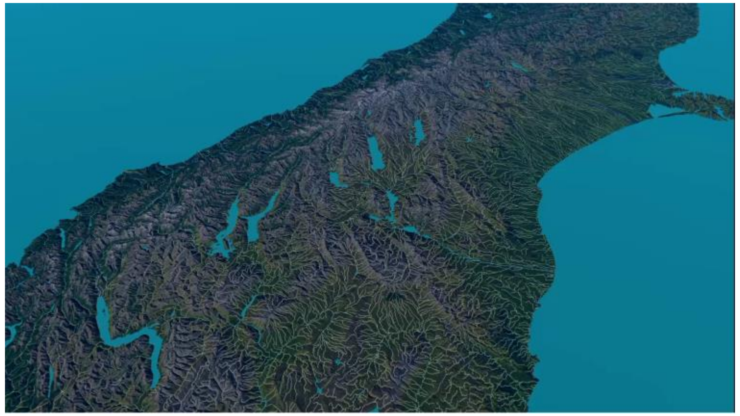
- Removed bias
- Larger errors cumulate daily
- Forecast a little narrow, too much temporal correlation?

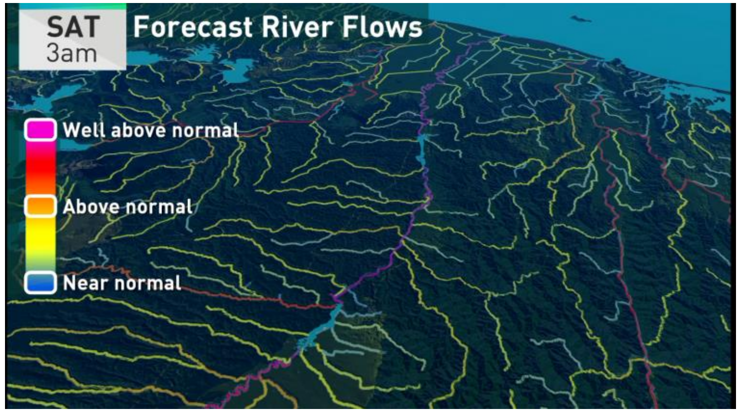
Approach #3:
Daily data

- Removed bias
- Smaller ensemble ranges
- Reliable ensemble (daily totals)
- Edge effects ☹

Conclusions

1. National flow forecasting system for New Zealand





2. BJP rainfall post-processing: Daily data and hourly forecasts

Approach #1:
Baseline- Hourly data

Approach #2:
Pseudo-hourly data

Approach #3:
Daily data

3. <u>Refine approach</u>:
   Combine daily and pseudo-hourly approaches?

Thank you!